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ABSTRACT

The purposes of this study were to: (1) identify interaction patterns that emerged during mathematics instruction in elementary school classrooms that established an "inquiry" mathematics tradition, (2) describe any gender-related differences in these patterns, and (3) attempt to account for the presence or absence of such differences. Preliminary analysis suggests that aspects of an inquiry approach to mathematics instruction may have had a positive impact in providing gender-equitable learning opportunities for boys and girls. (Author/MKR)

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GENDER-RELATED DIFFERENCES IN INTERACTION PATTERNS IN ELEMENTARY SCHOOL INQUIRY MATHEMATICS CLASSROOMS

Diana Underwood Gregg, Purdue University Calumet

The purpose of this study was to identify interaction patterns that emerged during mathematics instruction in elementary school classrooms which established an "inquiry" mathematics tradition, to describe any gender-related differences in these patterns, and to attempt to account for the presence or the absence of such differences. Preliminary analysis suggests that aspects of an inquiry approach to mathematics instruction may have had a positive impact in providing gender-equitable learning opportunities for boys and girls.

Gender differences in mathematics teaching and learning have been studied by numerous researchers over the past twenty years (Eccles & Blumenfeld, 1985; Fennema & Sherman, 1978; Hart, 1989; Jungwirth, 1991; Leder, 1992). In general, these studies have evolved from findings which indicate that males tend to outperform females in mathematics on standardized measures, and that females are less likely than males to take non-compulsory courses in high school mathematics.

In an effort to account for these phenomena, researchers have studied gender-related differences in males and females' beliefs about their mathematics abilities, differences in behaviors that females and males exhibit as a result of their beliefs, the influence of social interaction on their beliefs and behaviors, and gender-related differences in classroom interaction patterns. However, the vast majority of the studies that have noted differences in beliefs, behaviors, and/or interactions have taken place in classrooms characterized by what Cobb, Wood, Yackel, and McNeal (1992) call the *school mathematics tradition*. In this tradition, students are typically expected to learn and become proficient at solution methods and procedures that are presented to them by the teacher and their textbooks.

This tradition is in contrast to the *inquiry mathematics tradition* advocated in the current reform movement in mathematics education. In an inquiry mathematics classroom, the emphasis is on figuring out personally meaningful solutions and engaging in mathematical reasoning, explanation, and justification. Since the activities of explaining and justifying are central aspects of inquiry instruction, but not of traditional school mathematics instruction, the interaction patterns that occur in inquiry classrooms contrast dramatically with those of school mathematics classrooms (Cobb, et al., 1992). This suggests that inquiry classrooms are potentially rich sources for studying gender-related differences in attitudes, beliefs and motivations.

An important question that arises then is the following: How might a qualitative change in mathematics instruction influence the patterns of interaction that arise in the classroom and thereby influence students' learning opportunities with respect to gender? Will the gender-related differences recorded in the past continue to perpetuate inequitable learning opportunities for males and females or

SE 057232

could an inquiry mathematics classroom tradition provide a more gender-equitable environment? This study begins to address this question.

Theoretical Focus

The theoretical framework that guides this research stems from symbolic interactionism (Blumer, 1969) and ethnomethodology (Garfinkel, 1967). Under these assumptions, individuals in a group construct subjective meanings for things by interpreting each others' actions and adjusting their interpretations in the course of their interactions. Although meanings are subjective, they are experienced as universal truths by the participants within an interaction. Therefore, when applied to the analysis of mathematics lessons in schools, this point of view assumes that the individuals' mathematical activity is reflexively related to the classroom microculture (Voigt, 1992).

Guiding Research Questions

The research questions that guide this study are the following: 1) What are the typical patterns of interaction that emerge during whole class mathematics instruction that follows the inquiry tradition? 2) What, if any, are the gender-related differences in the interaction patterns during whole class, teacher-led activities? 3a) If there are gender-related differences in the patterns of interaction, then how are the gender-specific interaction patterns interactively constituted? and 3b) If there are no gender-related differences in the patterns of interaction, then are there aspects of the *inquiry* approach to instruction that can account for this lack of gender-related differences?

Data Collection

The mathematics instruction in two second and two third grade classrooms was video-recorded for two consecutive weeks during the last two months of the 1992-1993 school year. The classroom teachers conducted all the lessons using instructional activities and strategies that had been developed by the Purdue Problem-Centered Mathematics Project. Interviews were conducted with eight children from each of the 4 classes to gain information about their mathematical conceptual understandings as well as their perceptions of classroom events, their motivation for participating in whole-class discussions, and their views about their mathematics ability.

Methods of Analysis

In the first stage of the data analysis, transcripts of the mathematics lessons are currently being analyzed using a constant comparative approach (Glaser and Strauss, 1967). After transcribing each lesson, *theoretical memos* are written for each interaction sequence. These memos contain my interpretations and hypotheses about the meaning of events to the participants and serve as the basis for interpretation of subsequent lessons. With each analysis of subsequent episodes,

the conjectures previously made regarding comparable sequences are tested, refined or set aside. In the second stage of the analysis, the knowledge gained from the interviews with the target students and their teachers will be used as a means of triangulating or refuting assertions made in the first stage of the analysis.

Findings

I will discuss the preliminary findings from two of the four classrooms—Mary's and Josette's (both names are pseudonyms). The typical smooth flow of discourse in interactions in traditional classrooms has been described by Mehan (1979) as the initiation-response-evaluation scheme (i.e., the teacher asks a known-answer question, a student answers the question, and the teacher evaluates the answer). In contrast to this pattern, the smooth discourse in Mary's class when there was no disagreement about the answer to a task could be described as initiation-response-evaluation-echo, response-evaluation-echo, response-evaluation-echo, etc. Mary began by posing a task for which no precursory instruction had been given (initiation). A student, usually a volunteer, directed his/her response in the form of an answer to the task followed by his/her solution (response). Whereas in traditional school mathematics instruction in which the teacher assumes the role of the sole evaluator of the students' answers, in this class the students became a community of validators by calling out something that would suggest whether or not they agreed with the answer/solution that was given (evaluation). The teacher followed this by repeating the student's answer/solution back to the other members of the class, or by helping the student express what she thought the student was trying to say. Because the teacher only contributed to helping the student clarify his/her solution but never intentionally altered the nature of the student's solution, the last part of this recurring pattern is described as an "echo" of the student's answer/solution. Following her echo, Mary called on several other students for their responses to the original question. These were also evaluated by the students and then echoed by the teacher. Thus, instead of the typical school mathematics role as trainer and evaluator, Mary's role could be likened to that of a moderator.

When a student gave an answer or solution which was evaluated as incorrect by his/her peers, the class discussion would "breakout" as students would simultaneously begin calling out their arguments against the answers/solutions that were given. The breakout ended when the teacher reassumed the role of turn taking monitor and gave the floor to a student, thus ending the simultaneous talk. Although she typically would return to the student whose answer was disputed to see if s/he had, in Mary's words, "changed his/her mind", Mary never pressured students into changing their answers. In fact, just the opposite situation appeared to be the norm in this class. Even though she allowed the breakout in the classroom discourse to occur (and I would argue that she needed the breakouts to occur because she would not openly evaluate the answers herself), Mary unwaveringly upheld the students' right to state their solution without being interrupted, and to not be obligated to change their answer for *any* reason.

Based on the analysis of the patterns of interaction in Mary's class and previous literature, several gender-specific questions arose. Only one will be discussed here:

- What role does gender play in teacher-male vs. teacher-female interactions that involved attempts to gain the floor?

Both females and males used similar strategies to get a turn, such as calling out "I got something different" or "I did it a different way." Occasionally, both males and females would call out at inappropriate times, making it difficult for them to get a turn. However, there were a small number of incidents in the data in which the girls, in order to provide a rationale for why they should be given a turn to present their solution to a specific problem, would proclaim that they had "problems", it was "hard" for them to get their answer, or that their solution was "confusing". What makes this interesting is that the girls were not using this strategy as a means of getting help to solve problems that they perceived to be too difficult for them to solve. In other words, they were not exhibiting learned helpless behaviors. All of the girls who used this strategy to get a turn had invented viable solutions for the problems which they subsequently presented to the class.

A few years ago, the Mattel Toy Company, makers of the Barbie doll, came under fire when one of the phrases that their talking Barbie had been programmed to say was that "math is hard". By saying that "math is hard", Barbie was supposedly reinforcing the stereotype that for girls, math was too difficult. In the school mathematics tradition, if one believes that math is hard, this implies that he/she is probably not able to easily solve school math problems. This indicates that he/she has limited mathematical abilities. In Mary's class, it was taken-as-shared that math was sometimes "hard". However, "hard" had a different meaning for the students in this classroom than for those who have experienced traditional school mathematics instruction. When students or Mary described a problem as "hard", it did not mean that the participants believed that the problems were beyond their ability to solve it. Problems that were described as being "hard", "difficult" or "confusing" meant that students had to work harder at figuring them out. When the girls in this class described a task as "hard", they were not lowering their status by indicating a lack of competency (which might be the case in traditional school mathematics classrooms).

One of the reasons for the lack of gender-related differences in the patterns of interaction in Mary's class might be her role as moderator rather than evaluator and trainer. Mary did not have a mathematical agenda that she was trying to get the students to "see." Jungwirth (1991) found that, in traditional classrooms, boys may be more apt than girls to play along with the teacher's agenda and thus appear more competent. In Mary's case, her role as moderator promoted an atmosphere of trust in which the students knew that Mary would value all of their responses. This atmosphere contributed to a situation in which the students were not afraid to accept the challenge of problems that they were not sure they would be able to solve.

In contrast to Mary's role as moderator, Josette was not so equally accepting of all students' answers/solutions. Less sophisticated solutions typically received less recognition from the teacher. Whereas Mary "echoed" all solutions, Josette did not "echo" solutions in which students counted by ones to solve a problem. Furthermore she often elicited solutions that students figured out "without counting" and highlighted more sophisticated solutions when they appeared to fit with her agenda for the task. When students gave an answer that Josette considered to be wrong, she did not directly tell them that they were "wrong", but the rising inflection in her voice that she often used when she repeated their answer/solution was typically interpreted by students as an indicator that their answers were wrong. Thus, the typical pattern of interaction in Josette's class more closely resembled the tradition initiation-response-evaluation pattern.

Josette's subtle evaluation of students' answers was often followed by a modification in the typical pattern of interaction that corresponded to the "breakout" pattern in Mary's class. However, whereas the "breakout" pattern was played out in Mary's classroom interactions when students judged an answer to be incorrect, this open forum for calling out one's disagreement with a peer's answer/solution was not practiced in Josette's class. In Josette's class, if a student disagreed with an answer/ solution given by his/her peers, norms had been established prior to the data collection period in which the student who disagreed was under the obligation to ask the student who provided the solution questions about the aspects of the answer/solution which he/she disagreed with. Unlike in Mary's class in which students who gave a "wrong" answer were not obligated to address arguments regarding their solutions, the students in Josette's class could not hold on to an answer/solution without addressing these arguments.

Although no gender differences were noted in interactions when students questioned each others' solutions, the following gender-specific question arose:

- What role does gender play in the teacher-student interactions when students' answers/solutions are judged to be incorrect?

When Josette judged an answer/solution to be wrong, she was much more directive in her interactions with some students than she was with others. However, the data analysis indicated that the differences in these interactions were not related to the student's gender, but to Josette's perception of the different cognitions of the students. Josette interacted similarly with strong females and strong males. When a strong student gave an atypical answer which might have been judged as being incorrect, Josette would indicate that *she* was having trouble figuring out how they had solved the task and would ask the student for a clarification. When a mathematically less able student began to present a solution that did not fit with a solution that she expected to hear, Josette would cut off the student's explanation before s/he could complete it and steer her/him to what she considered an acceptable solution for that task. There were also not any gender differences in the ways in which males and females responded to this steering. For instance, both weak females and weak males accepted the funneling in the same manner.

Neither boys nor girls would contradict the teacher's negative evaluation and steering to a different solution even when their solutions were correct.

A possible reason why there were not any gender related differences in the patterns of interaction in Josette's class might be because Josette's focus was on how she was supposed to "do" the instructional activities so that students would learn. Josette seemed to have a "script" that she followed for each activity that she and the students engaged in. It seems possible that she was so preoccupied with following the "script" for the instructional task that she did not pay much attention to the students' mathematical conceptions unless their solutions did not fit her script. For those cases when things did not go smoothly, she had take action to get students back on track with the script. As noted, these actions differed according to Josette's perception of students' abilities, but not according to their gender.

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